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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY  
(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

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|---|--|--|--|--|
| Applicant's or agent's file reference<br>BPCL 9966  |  | <b>FOR FURTHER ACTION</b>  |  | See Form PCT/PEA/416                         |
| International application No.<br>PCT/GB2004/001278  |  | International filing date (day/month/year)<br>24.03.2004                             |  | Priority date (day/month/year)<br>03.04.2003 |
| International Patent Classification (IPC) or national classification and IPC<br>C07C5/333, C10G11/00, C10G11/22, C07C11/02, C07C11/04, C07C11/06  |  |  |  |  |
| Applicant<br>BP CHEMICALS LIMITED et al.  |  |  |  |  |
| <p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 8 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> sent to the applicant and to the International Bureau) a total of 3 sheets, as follows:</p> <p><input checked="" type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p>b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p> |  |  |  |  |
| <p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the opinion</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input type="checkbox"/> Box No. VIII Certain observations on the international application</p>  |  |  |  |  |
| Date of submission of the demand<br><br>18.10.2004  |  | Date of completion of this report<br><br>28.06.2005                                  |  |  |
| Name and mailing address of the International preliminary examining authority:<br> European Patent Office<br>D-80298 Munich<br>Tel. +49 89 2399 - 0 Tx: 523656 epmu d<br>Fax: +49 89 2399 - 4465   |  | Authorized Officer<br><br>Lorenzo Varela, M.J.<br><br>Telephone No. +49 89 2399-8239 |  |  |



**INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITY**

International application No.  
PCT/GB2004/001278

**Box No. I Basis of the report**

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
  - ☐ publication of the international application (under Rule 12.4)
  - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements\*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report):*

**Description, Pages**

1-19 as originally filed

**Claims, Numbers**

1-14 filed with telefax on 10.01.2005

**Drawings, Sheets**

1/1 as originally filed

- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing
3. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
  - ☐ the claims, Nos.
  - ☐ the drawings, sheets/figs
  - ☐ the sequence listing (*specify*):
  - ☐ any table(s) related to sequence listing (*specify*):
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
- ☐ the description, pages
  - ☐ the claims, Nos.
  - ☐ the drawings, sheets/figs
  - ☐ the sequence listing (*specify*):
  - ☐ any table(s) related to sequence listing (*specify*):

\* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITY**

International application No.  
PCT/GB2004/001278

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**Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

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**1. Statement**

|                               |             |       |
|-------------------------------|-------------|-------|
| Novelty (N)                   | Yes: Claims | 13,14 |
|                               | No: Claims  | 1-12  |
| Inventive step (IS)           | Yes: Claims |       |
|                               | No: Claims  | 1-14  |
| Industrial applicability (IA) | Yes: Claims | 1-14  |
|                               | No: Claims  |       |

**2. Citations and explanations (Rule 70.7):**

**see separate sheet**

**Re Item V**

**Reasoned statement with regard to novelty, inventive step or industrial applicability;  
citations and explanations supporting such statement**

- D1: EP-A-0 529 793 (BRITISH PETROLEUM CO PLC) 3 March 1993 (1993-03-03)  
D2: BRIDGES R S ET AL: "RECYCLE BUTENES TO CRACKING" November 1986 (1986-11), HYDROCARBON PROCESSING, GULF PUBLISHING CO. HOUSTON, US, PAGE(S) 71-74 , XP001048615 ISSN: 0018-8190  
D3: EP-A-1 001 001 (NOVA CHEM INT SA) 17 May 2000 (2000-05-17)  
D4: US-A-4 044 068 (KURTZ BRUCE E) 23 August 1977 (1977-08-23)  
D5: US-A-5 981 818 (PURVIS DAVID ET AL) 9 November 1999 (1999-11-09)  
D6: US-B-6 395 9441 (GRIFFITHS DAVID CHARLES ET AL) 28 May 2002 (2002-05-28)  
D7: WO 94/04632 A (BP CHEM INT LTD) 3 March 1994 (1994-03-03)
1. The present application relates to a process for the production of olefins such as ethene and propene by autothermally cracking a paraffinic hydrocarbon-containing feedstock, at least one unsaturated hydrocarbon and a molecular oxygen-containing gas in the presence of a catalyst.
  2. D1 discloses a process for the production of olefins such as ethene and propene by autothermally cracking a paraffinic hydrocarbon-containing feedstock, at least one unsaturated hydrocarbon such as benzene and toluene and a molecular oxygen-containing gas in the presence of a catalyst (see the passages mentioned in the search report).
  3. D2 discloses the beneficial effects of recycling butenes in the cracking of paraffins to olefins.
  4. D3 discloses a process for the production of olefins such as ethene and propene by cracking a paraffinic hydrocarbon-containing feedstock, at least one unsaturated hydrocarbon recycled in the process such as ethylene and a molecular oxygen-containing gas in the presence of a catalyst (see the passages mentioned in the search report).

5. D4-D6 disclose a process for the production of olefins such as ethene and propene by autothermally cracking a paraffinic hydrocarbon-containing feedstock, at least one unsaturated hydrocarbon recycled in the process and a molecular oxygen-containing gas in the presence of a catalyst (see the passages mentioned in the search report).
6. D7 discloses a process for the production of olefins such as ethene and propene by autothermally cracking a paraffinic hydrocarbon-containing feedstock and a molecular oxygen-containing gas in the presence of a catalyst.

Novelty

7. The subject-matter of claims 1, 2, 5, 7-10 and 12 is not novel in the sense of art. 33(2) PCT.
  - 7.1. D1 discloses a process for the production of olefins such as ethene and propene by autothermally cracking a paraffinic hydrocarbon-containing feedstock, at least one unsaturated hydrocarbon such as benzene and toluene and a molecular oxygen-containing gas in the presence of a catalyst (see the passages mentioned in the search report). This disclosure anticipates the subject-matter of claims 1, 2, 5 and 7, which is therefore not novel. The applicant argues that the paraffinic hydrocarbon-containing feedstock and the at least one unsaturated hydrocarbon are different feeds in the application whilst both components are in one feed in D1. However, in the drafting of the main claim 1 both components can be in the same feed. Therefore, the subject-matter of claims 1, 2, 5 and 7 is not novel.
  - 7.2. D4 and D6 disclose a process for the production of olefins such as ethene and propene by cracking a paraffinic hydrocarbon-containing feedstock, at least one unsaturated hydrocarbon recycled in the process such as ethylene and a molecular oxygen-containing gas in the presence of a catalyst (see the passages mentioned in the search report). Taking into account that olefins are obtained in the process and that a part of the reaction medium is recycled to the autothermic cracker, this disclosure anticipates the subject-matter of claims 1, 2, 5 and 7-10, which is therefore not novel.

The applicant argues that the process in D4 does not partially combust the hydrocarbon

in the presence of a catalyst capable of supporting combustion beyond the normal fuel rich limit of flammability and use the heat from this one to drive cracking; however as the process in D4 is as well autothermic and it takes places in the presence of a catalyst, it is considered novelty destroying for the above-mentioned claims taking into account that the terms "catalyst capable of supporting combustion beyond the normal fuel rich limit of flammability" do not clearly disclose the type of catalyst and therefore any catalyst capable of supporting combustion of the hydrocarbon in an autothermic process can be used in the process.

The applicant argues that in D6, the specific amount of unsaturated hydrocarbon in the feed which is recycled to the catalyst is not indicated; however, an amount from 1 to 20wt% of unsaturated components in a naphtha fraction is normally present and therefore, this disclosure is novelty destroying for the above-mentioned claims.

8. The subject-matter of claims 3, 4, 6, 11 and 12 does not seem to be novel in the sense of Art. 33(2) PCT in view of documents D4 and D6. Taking into account that a part of the reaction medium is recycled to the autothermal cracker and in view that dienes and alkynes are obtained usually in the cracking process of paraffinic hydrocarbons to olefins, the subject-matter of claims 3, 4, 6, 11 and 12 does not seem to be novel.

**Inventive step**

9. The subject-matter of claims 13 and 14 cannot be considered to involve an inventive step in the sense of Art. 33(3) PCT.
- 9.1. Autothermal cracking for the production of olefins from a paraffinic hydrocarbon-containing feedstock, at least one unsaturated hydrocarbon (usually recycled in the process) and a molecular oxygen-containing gas in the presence of a catalyst is known in the art (D1, D4 and D6).
- 9.2. The beneficial effects of recycling butenes in the cracking of paraffins to olefins are known as well (D2).
- 9.3. In view of the teaching of the prior art (paragraphs 9.1 and 9.2), dependent claims 13

and 14 do not contain any feature which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step.

Further comments

10. Claims 1, 9, 10, 12 and 13 do not meet the requirements of Article 6 PCT in that the matter for which protection is sought is not clearly defined. The claims attempt to define the subject-matter in terms of the result to be achieved, which merely amounts to a statement of the underlying problem, without providing the technical features necessary for achieving this result. The expression "a catalyst capable of supporting combustion beyond the normal fuel rich limit of flammability" does not allow the skilled person in the art to know beforehand which catalysts fulfil the above-mentioned requirement. Undue experimentation would be required to randomly screen which catalysts fall within the scope of the claim. Furthermore, only catalysts containing platinum have been used in the application. Therefore, such a broad generalisation is not justified. Hence, the subject-matter of the claims should have been drafted specifying that platinum containing catalysts are used.
11. Terms introduced by terms like "preferably" or "such as" have no limiting effect on the scope of the claim including them (see PCT Guidelines, C-III, 4.6). The presence of such non-limiting features is however detrimental to the conciseness of claims 3, 4, 6, 7 and 11, contrary to Art. 6 PCT.
12. Claim 9 should have been drafted as dependant on claim 1 and add only the steps which are not included in claim 1. The actual wording of the claims leads to lack of conciseness and as such do not meet the requirements of Article 6
13. Although claims 13 and 1 have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought. The aforementioned claims therefore lack conciseness and as such do not meet the requirements of Article 6 PCT. Claim 13 should have been drafted depending on claim 1.

**INTERNATIONAL PRELIMINARY  
REPORT ON PATENTABILITY  
(SEPARATE SHEET)**

International application No.

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15. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents D1, D2, D4 and D6 is not mentioned in the description, nor are these documents identified therein.
16. The description has not been adapted to the amended claims, contrary to Rule 5.1 a) iii) PCT.



9966(2)

Claims:

1. A process for the production of olefins which process comprises feeding (i) a paraffinic hydrocarbon-containing feedstock, (ii) ~~at least one unsaturated hydrocarbon~~ and (iii) a molecular oxygen-containing gas to an autothermal cracker, wherein they are reacted in the presence of a catalyst capable of supporting combustion beyond the  
5 normal fuel rich limit of flammability to provide a hydrocarbon product stream comprising olefins, characterised in that at least one unsaturated hydrocarbon is co-fed with the paraffinic hydrocarbon feed and the molecular oxygen-containing gas to the autothermal cracker, and wherein the unsaturated hydrocarbon has a weight percentage of between 1-20wt% based on the weight of paraffinic hydrocarbon.
- 10 2. A process according to claim 1, wherein the unsaturated hydrocarbon is one or more of an alkene, an aromatic compound, a diene and an alkyne.
3. A process according to claim 2, wherein the unsaturated hydrocarbon is 1,2 butadiene, 1,3 butadiene, 2 methyl 1,3 butadiene, 1,3 pentadiene, 1,4 pentadiene and/or cyclopentadiene, preferably 1,3 butadiene.
- 15 4. A process according to claim 2, wherein the unsaturated hydrocarbon is acetylene, propyne and/or a butyne, preferably acetylene.
5. A process according to claim 2, wherein the autothermal cracker is operated at a total pressure of greater than 5 barg and the unsaturated hydrocarbon is benzene and/or toluene.
- 20 6. A process according to any one of the preceding claims wherein the unsaturated hydrocarbon fed to the autothermal cracker comprises at least one unsaturated hydrocarbon other than an alkene, such as at least one of a diene and an alkyne, and less

than 1wt%, such as less than 0.5wt%, of total alkenes, based on the weight of paraffinic hydrocarbon fed to the reactor.

7. A process according to any one of the preceding claims wherein the unsaturated hydrocarbon derives from the product stream of a steam cracking reactor, the off gas stream of a fluid catalytic cracking reactor, the off gas streams of a delayed coker unit, a visbreaker unit or an alkylation unit or from a plastics recycling process, such as pyrolytic polymer cracking.

8. A process according to any one of the preceding claims wherein the unsaturated hydrocarbon fed to the autothermal cracking reactor derives from the autothermal cracking product stream.

9. A process according to claim 8, which process comprises the steps of:  
(a) feeding a paraffinic hydrocarbon-containing feedstock and a molecular oxygen-containing gas to an autothermal cracker wherein they are reacted in the presence of a catalyst capable of supporting combustion beyond the normal fuel rich limit of flammability to provide a hydrocarbon product stream comprising olefins  
(b) recovering at least a portion of the olefins produced in step (a) and  
(c) recycling at least one unsaturated hydrocarbon produced in step (a) back to the autothermal cracker.

10. A process according to claim 9 which process comprises the steps of:  
(a) feeding a paraffinic hydrocarbon-containing feedstock and a molecular oxygen-containing gas to an autothermal cracker wherein they are reacted in the presence of a catalyst capable of supporting combustion beyond the normal fuel rich limit of flammability to provide a hydrocarbon product stream comprising ethene and/or propene

(b) separating the hydrocarbon product stream produced in step (a) into a first stream comprising hydrocarbons containing less than 4 carbon atoms and a second stream comprising hydrocarbons containing at least 4 carbon atoms, including at least one unsaturated hydrocarbon containing at least 4 carbon atoms

(c) recovering ethene and/or propene from the first stream and  
(d) recycling at least a portion of the second stream to the autothermal cracker.

11. A process according to claim 10 wherein the unsaturated hydrocarbon containing at least 4 carbon atoms is selected from 1,2 butadiene, 1,3 butadiene, 2

methyl 1,3 butadiene, 1,3 pentadiene, 1,4 pentadiene and cyclopentadiene, and preferably is 1, 3 butadiene.

12. A process according to claim 9 which process comprises the steps of:

(a) feeding a paraffinic hydrocarbon-containing feedstock and a molecular oxygen-containing gas to an autothermal cracker wherein they are reacted in the presence of a catalyst capable of supporting combustion beyond the normal fuel rich limit of flammability to provide a hydrocarbon product stream comprising ethene and/or propene, and at least one alkyne

(b) recovering at least a portion of the ethene and/or propene produced in step (a) and

(c) recycling at least a portion of the at least one alkyne produced in step (a) back to the autothermal cracker.

13. A process for the production of olefins which process comprises feeding a paraffinic hydrocarbon, at least one unsaturated hydrocarbon and a molecular oxygen-containing gas to an autothermal cracker wherein they are reacted in the presence of a catalyst capable of supporting combustion beyond the normal fuel rich limit of flammability to provide a hydrocarbon product stream comprising olefins, said process being characterised in that the total hydrocarbon fed to the autothermal cracker comprises at least 20wt% of unsaturated hydrocarbons.

14. The process according to claim 13 wherein the total hydrocarbon fed to the autothermal cracker comprises at least 10wt% olefins and at least 10wt% aromatics.